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F2S SBF S102 S113 S121 S301
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(56) Documents Cited
GB 2311354 A GB 2266133 A GB 2124328 A
US 5823306 A

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(54) Abstract Title
A shock absorber of the piston and cylinder type incorporating an hydraulic lockout mechanism

(57) The hydraulic lockout mechanism uses an additional lockout piston (28) secured to the piston rod (16) which employs a flexible intake valve (30) to dampen the motion of the piston rod (16) of the shock absorber (10) as the piston rod (16) moves into a position of full extension. When the piston rod (16) initially moves out of full extension into a position of compression, the flexible intake valve (30) of the mechanism flexes to allow fluid to flow through several passageways (34) in the lockout piston (28) of the mechanism. This allows the pressure on both sides of the lockout piston to be equalised quickly and removes the reactive force that would otherwise be experienced by the piston rod as it initially moves out of a position of full extension.

FIGURE 4

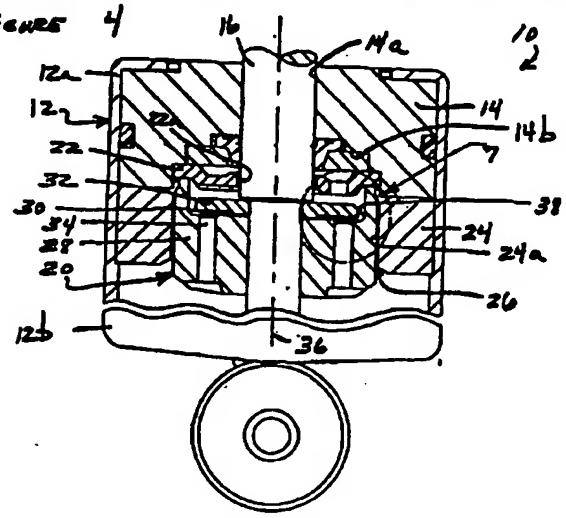

FIGURE 7

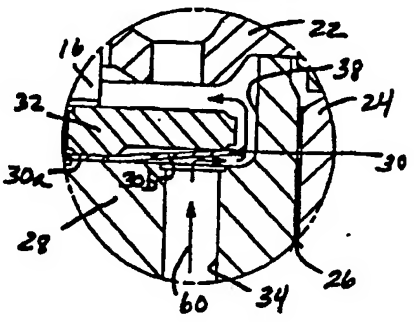

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FIGURE 1

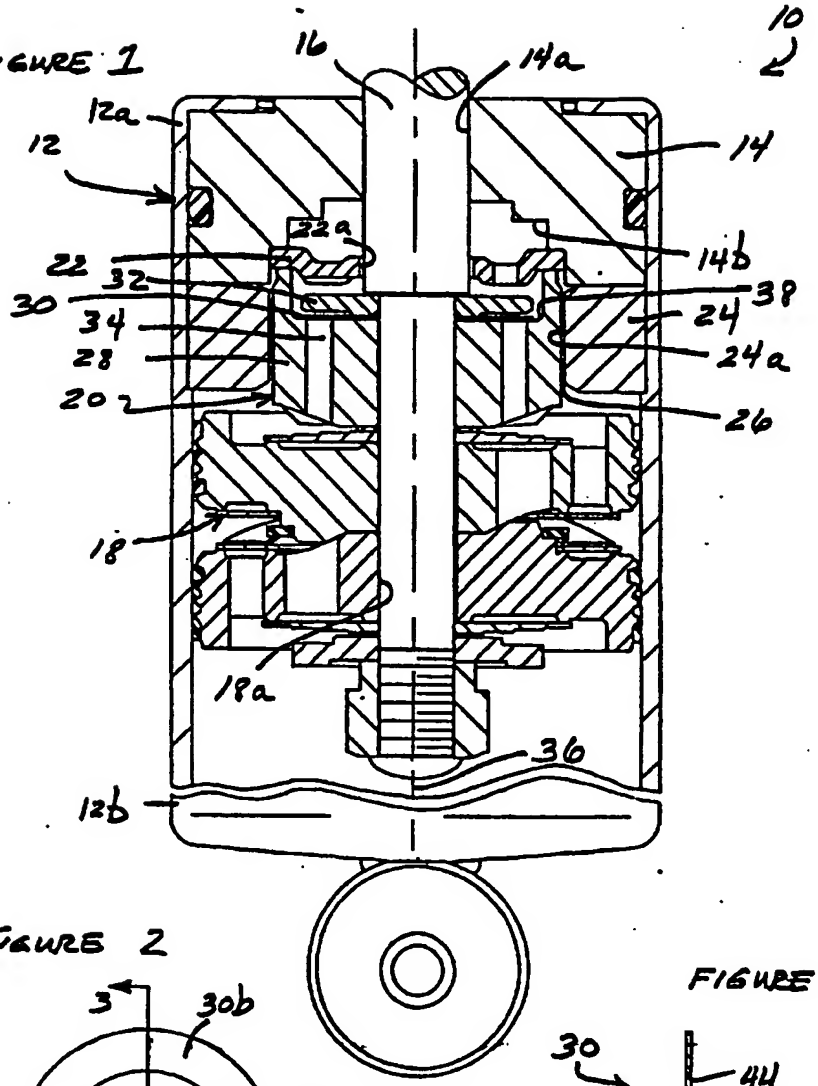


FIGURE 2

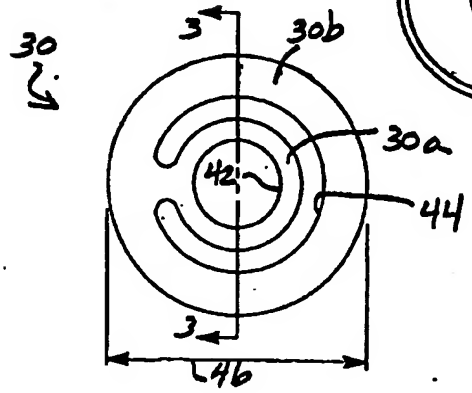


FIGURE 3

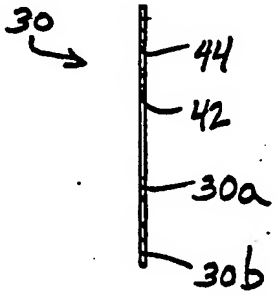


FIGURE 4

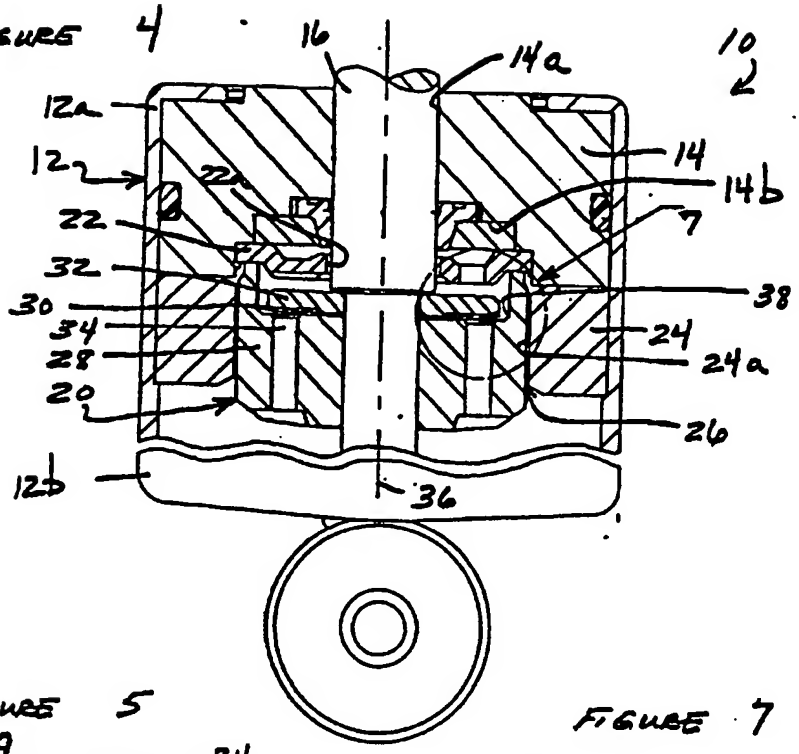


FIGURE 5

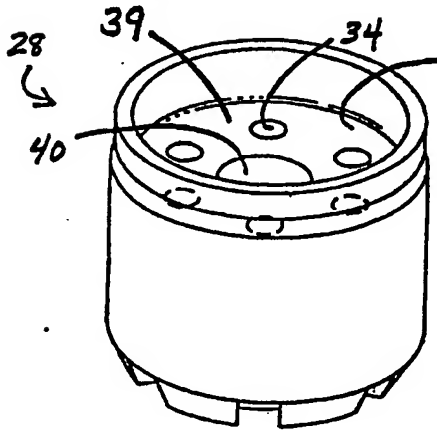
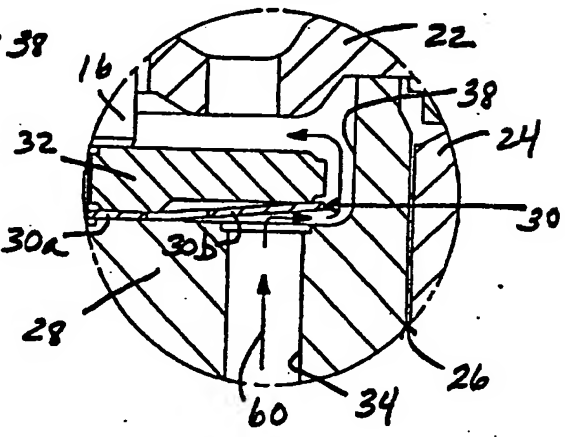


FIGURE 7



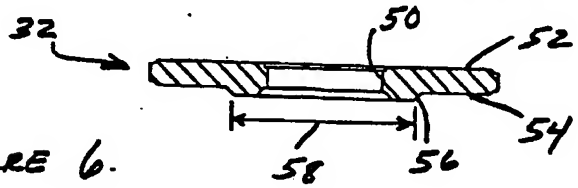


FIGURE 6.

SHOCK ABSORBER INCLUDING LOCKOUT PISTON HAVING FLEXIBLE CHECK VALVE

BACKGROUND OF THE INVENTION

Technical Field

This invention relates to shock absorbers, and more particularly to a shock absorber including a lockout piston having a flexible check valve which assists in equalizing the pressure on both sides of the lockout piston as the piston moves from full extension toward full compression.

Discussion

Shock absorbers are used in a wide variety of applications involving motor vehicles. Such shock absorbers typically include a housing having a portion coupled to an unsprung portion of a vehicle and a piston rod disposed partially within the housing. One end of the piston rod is coupled to the sprung portion of the vehicle such as a shock tower. The piston rod also typically includes a damping piston disposed within the housing which effectively damps movement of the piston rod within the housing as the piston rod moves between positions of extension and compression during operation of the vehicle.

Some shock absorbers also incorporate some form of stroke limiting means for further damping movement of the piston rod and its attached damping piston when the piston rod moves to a position of full extension. However, even with such stroke limiting devices, once the piston rod is in the fully extended position and then initially

begins moving in the compression direction, the piston rod experiences a reactive force. This reactive force is th force n eded to initially begin displacing hydraulic fluid within the housing which has collected on one side of the lockout device to a position on the opposite side of the lockout device. Typically, the fluid must be forced through a small annulus formed between the outer periphery of the lockout piston and the inner wall of the housing, or a sleeve disposed within the housing, within which the lockout device travels. This reactive force serves to stress the piston rod and other components of the shock absorber and negatively affects the ride characteristics of the vehicle whenever the piston rod is forced to move from a position of full extension into compression.

It is therefore a principal object of the present invention to provide an hydraulic lockout device which serves to damp the motion of, and remove the kinetic energy from, suspension components attached to a piston rod of the shock absorber, while also removing substantially the reactive force experienced by the piston rod when same is moved out of a position of full extension into a position of compression.

It is a further object of the present invention to provide a shock absorber having an hydraulic lockout device which is formed from a small number of independent components which do not add appreciably to the overall cost of the shock absorber or to its complexity of manufacture, and which serve to help remove the reactive force experienced by a piston rod of the shock absorber when the piston moves out of a position of full extension into compression.

It is yet another object of the present invention to provide a shock absorber having an hydraulic lockout device which serves two functions, namely damping the

motion of a piston rod attached thereto as the piston rod moves into a position of full extension, and also which removes substantially the reactive force experienced by the piston rod when the piston rod is initially moved ut of a position of full extension into compression.

SUMMARY OF THE INVENTION

The above and other objects are provided by a shock absorber having an hydraulic lockout mechanism. The hydraulic lockout mechanism is fixedly secured to a piston rod and moves within a sleeve inside of a housing of the shock absorber. The hydraulic lockout device includes a lockout piston having a plurality of channels which allow fluid to pass therethrough and damps movement of the piston rod as same moves between a position of compression into full extension. The hydraulic lockout device includes a flexible check valve which is also fixedly secured to the piston rod adjacent one side of the hydraulic lockout piston. The flexible check valve covers the fluid passageways in the lockout piston when the piston rod is moved towards and into a position of full extension, thereby forcing fluid on one side of the lockout piston through a small annulus formed between the lockout piston and the sleeve to damp the motion of the piston rod as it moves into full extension.

The flexible check valve operates to flex slightly to uncover the fluid passageways and the lockout piston as soon as the piston rod begins moving out of full extension into compression. This enables fluid on the opposite side of the lockout piston to move through the fluid passageways in the lockout piston to quickly equalize the pressure on both sides of the lockout piston. This serves to significantly reduce the reactive force that the piston rod experiences as it first begins to move out of a

position of full extension into a position of compression and therefore the objectionable ride characteristics that the reactive force produces.

In a preferred embodiment a supporting element in the form of a support washer is also secured to the piston rod over the flexible check valve. The support washer has a central or first portion and a peripheral or second portion. The central portion comprises a raised portion which serves to offset the peripheral portion slightly from the check valve when the support washer is secured to the piston rod adjacent the check valve. The clearance between the peripheral portion of the support washer and a peripheral portion of the check valve allows the peripheral portion of the check valve to flex slightly as soon as the piston rod begins moving out of full extension.

To further enable the check valve to flex readily as soon as the piston rod begins moving out of full extension, the check valve, in one preferred embodiment, incorporates a circumferential slot. The slot is formed inwardly of the peripheral portion such that it does not affect the check valve's ability to block the fluid passageways in the lockout piston and yet allows the check valve to flex more easily when the piston rod and the lockout piston are moved out of full extension.

The apparatus of the present invention helps to substantially reduce or eliminate the reactive force experienced by the piston rod when it initially begins moving out of full extension. The apparatus does not add significantly to the overall number of independent component parts of the shock absorber, does not significantly increase its overall cost, dimensions or weight, nor does it significantly increase the complexity of manufacture of the shock absorber.

BRIEF DESCRIPTION OF THE DRAWINGS

Th various advantages of the present invention will become apparent to one skilled in the art by reading the following specification and subjoined claims and by referencing the following drawings in which:

Figure 1 is a cross sectional side view of a shock absorber incorporating the hydraulic lockout mechanism of the present invention showing the piston rod in a position of full extension;

Figure 2 is a plan view of the flexible check valve of the present invention;

Figure 3 is a cross sectional side view of the check valve of Figure 2 taken in accordance with section line 3-3 in Figure 2;

Figure 4 is a view of the shock absorber of Figure 1 showing the piston rod after it has just moved out of the position of full extension in the direction of compression.

Figure 5 is a perspective view of the lockout piston;

Figure 6 is an enlarged, cross sectional side view of the support element shown in Figure 1; and

Figure 7 is an enlarged view of a portion of the apparatus taken in accordance with circled portion 7 in Figure 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1, there is shown a shock absorber 10 for a motor vehicle. The shock absorber 10 includes a housing 12 having a first end portion 12a and a second end portion 12b. At the first end portion 12a is disposed a rod guide assembly 14 having a coaxially disposed opening 14a and a recessed area 14b. A piston rod 16

extends through the opening 14a into an interior area of the housing 12. An upper portion (not shown) of th piston rod 16 is attached to the sprung portion of a vehicle and the second end portion 12b to an unsprung portion of the vehicle.

Attached to the piston rod 16 is a damping piston assembly 18 having an opening 18a and an hydraulic lockout mechanism 20. An oil seal retainer 22 is disposed within the rod guide assembly 14 and includes a coaxial opening 22a through which the piston rod 16 extends. A sleeve forming a stop ring 24 is also disposed within the housing 12 adjacent the rod guide assembly 14 and includes a coaxial opening 24a which is slightly larger in diameter than the outer diameter of the hydraulic locking mechanism 20. As such, a small annulus 26 exists between the hydraulic lockout mechanism 20 and the stop ring 24 through which hydraulic damping fluid contained in the housing 12 may pass as the piston rod 16 moves between the position of full extension, shown in Figure 1, toward a position of compression.

With further reference to Figure 1, the hydraulic lockout mechanism 20 includes an hydraulic lockout piston 28, a flexible intake valve 30 and a disc-like support element 32. The lockout piston 28 has a plurality of bores forming fluid passageways 34 extending therethrough generally parallel to a longitudinal axis 36 extending through the shock absorber 10. The flexible check valve 30 is secured to the piston rod 16 together with the lockout piston 28 so as to be disposed within a recess 38 and against an upper surface 39 of the lockout piston 28.

With brief reference to Figure 5, the lockout piston 28 is shown in further detail. The fluid passageways 34 are spaced circumferentially about a central opening 40 through which the piston rod 16 extends. While six fluid passageways 34 are

illustrated, it will be appreciated that a greater or lesser number of passageways 34 could readily be formed.

With further reference to Figures 1, 2 and 3, the flexible check valve 30 forms a disc which is made from a single length of spring steel preferably about 0.004-0.020 inch thick, and more preferably about 0.013 inch thick. The check valve 30 includes a coaxially disposed opening 42 through which the piston rod 16 extends. A circumferential slot 44 having a width of preferably between about 0.150-0.180 inch is formed to increase the flexibility of the valve 30. The valve 30 can be viewed as including a first or inner portion 30a and a peripheral portion 30b. The overall width of the valve 30, as represented by dimensional arrow 46, is just slightly less than the diameter of the recess 38 formed in the lockout piston 28. Accordingly, the peripheral portion 30b of the valve 30 overlays the fluid passageways 34 of the lockout piston 28 once the valve 30 is assembled to the lockout piston 28 and onto the piston rod 16.

With reference to Figures 1 and 6, the support element 32 forms a washer which includes a coaxially disposed opening 50, an upper surface 52 and a lower surface 54. The lower surface 54 includes a raised circumferential shoulder 56 disposed coaxially about the opening 50. The outer diameter of the shoulder 56, as represented by arrow 58, is less than the inner diameter of the circumferential slot 44 of the flexible check valve 30 such that when the shock absorber 10 is assembled the shoulder 56 rests against the inner portion 30a of the check valve 30 inwardly of the slot 44. The support element 32 serves to hold the check valve 30 in the recess 38 of the lockout piston 28 while providing clearance for the outer peripheral portion 30b to flex.

Turning now to the operation of shock absorber 10, as the piston rod 16 is moved into a position of full extension, as shown in Figure 1, hydraulic fluid abov the lockout piston 28 is displaced to the area below the lockout piston 28 As the fluid flows through the annulus 26 formed between the stop ring 24 and the outer surface of the lockout piston 28. No fluid can flow through the fluid passageways 34 because same are blocked off by the check valve 30. The leakage of the trapped fluid through the annulus 26 at a very low rate effectively damps the motion of the piston rod 16 and any suspension components attached thereto as the piston rod 16 moves into full extension as shown in Figure 1.

Referring to Figure 4, when the piston rod 16 is moved initially out of full extension the movement of the hydraulic lockout piston 28 out of the stop ring 24 creates a low pressure above the lockout piston 28 resulting in a pressure drop across the check valve 30. This pressure drop creates a force causing the check valve 30 to flex slightly, thereby opening the fluid passageways 34 in the hydraulic lockout piston 28. The support element 32 limits the flexing to a predetermined degree. This action is shown in enlarged fashion in Figure 7. This allows the fluid to flow rapidly through the passageways 34, as indicated by arrows 60, to equalize the pressure on both sides of the lockout piston 28. The equalization of pressure above and below the lockout piston 28 allows the piston 28 to move out of the stop ring 24 with little or no reactive force experienced by the piston rod 16.

The hydraulic lockout mechanism 20 of the present invention therefore allows a piston rod of a shock absorber to move more easily out of a position of full extension such that the piston rod does not experience the high reactive force that would otherwise be experienced when moving initially out of full extension. This in turn eliminates or substantially reduces the objectionable ride characteristics that may result from requiring the piston road 16 to overcome the reactive force. The hydraulic lockout mechanism 20 further does not require a significant number of additional component parts, does not significantly increase the overall cost of the shock absorber, and does not significantly increase the complexity of assembly of the shock absorber 10.

Those skilled in the art can now appreciate from the foregoing description that the broad teachings of the present invention can be implemented in a variety of forms. Therefore, while this invention has been described in connection with particular examples thereof, the true scope of the invention should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, specification and following claims.

CLAIMS

1. A shock absorber comprising:

a housing containing a damping fluid;

a sleeve disposed at one end of said housing to close off said housing, said sleeve including a coaxially disposed opening;

a piston rod disposed within said housing and having a portion extending outwardly of said housing through said opening in said sleeve;

a damping piston secured fixedly to said piston rod within said housing;

a lockout piston secured fixedly to said piston rod within said housing intermediate said damping piston and said sleeve, and including at least one fluid passageway;

a flexible intake valve disposed fixedly on said piston rod adjacent said lockout piston for controlling the flow of said damping fluid through said fluid passageway in said lockout piston;

said flexible intake valve having dimensions permitting same to block fluid flow through said lockout piston when said piston rod is moved toward a position of full extension, and being operable to flex as said piston rod is initially moved from a position of full extension toward a position of compression, thereby allowing fluid flow through said lockout piston and equalizing the pressure on both sides of said lockout piston to minimize a reactive force on said piston rod.

2. The shock absorber of claim 1, further comprising:

a support washer having an opening through which said piston rod extends and fixedly secured to said piston rod and adapted to overlay a portion of said flexible intake valve to limit flexing movement of said flexible intake valve.

3. The shock absorber of claim 1 or claim 2, wherein said flexible intake valve comprises a metallic disc having a thickness in the range of about 0.004 - 0.020 inch.

4. The shock absorber of any one of claims 1 to 3, wherein said flexible intake valve further comprises a circumferential slot formed coaxially about said opening therein to enhance the flexibility thereof.

5. A shock absorber comprising:

a housing containing a damping fluid;

a guide assembly disposed at one end of said housing to close off said one end of said housing, said guide assembly having a coaxially disposed opening;

a sleeve disposed adjacent said guide assembly and having a coaxially disposed opening;

a piston rod disposed within said housing and having a portion extending outwardly of said housing through said opening in said sleeve and said opening in said guide assembly;

a damping piston secured fixedly to said piston rod within said housing;

a lockout piston secured fixedly to said piston rod within said housing intermediate said damping piston and said recess of said sleeve, said lockout piston including a plurality of fluid passageways therethrough extending generally parallel to a longitudinal axis extending through said housing and being of a dimension to move longitudinally within said opening in said sleeve;

a flexible intake valve having an opening through which said piston rod extends and being fixedly secured to said piston rod adjacent said lockout piston for controlling the flow of said damping fluid through said lockout piston, said flexible intake valve including a disc having a diameter sufficiently large to cover said fluid passageways in said lockout piston and overlaying said fluid passageways as said

piston rod is moved toward a position of full extension relative to said housing; and

said disc being operable to flex away from said lockout piston as said piston rod is initially moved from a position of full extension toward a position of compression, thereby allowing fluid flow through said fluid passageways of said lockout piston, thereby equalizing the pressure on both sides of said lockout piston to minimize a reactive force on the piston rod.

6. The shock absorber of claim 5, further comprising a support washer fixedly secured to said piston rod and adapted to overlay a portion of said flexible intake valve to hold said portion against said lockout piston.

7. The shock absorber of claim 6, wherein said support washer comprises:

a central portion which contacts said flexible intake valve to hold said valve against said lockout piston; and

a peripheral portion which limits the flexing movement of said flexible intake valve.

8. The shock absorber of any one of claims 5 to 7, wherein said flexible intake valve comprises a thickness of between about 0.004 - 0.020 inch.

9. The shock absorber of claim 8, wherein said flexible intake valve comprises a thickness of about 0.013 inch.

10. The shock absorber of any one of claims 5 to 9, wherein said flexible intake valve comprises a circumferential slot formed therein about said opening to enhance th

flexibility th reof.

11. The shock absorber of any one of claims 5 to 10, wherein said flexible intake valve is comprised of spring steel.

12. A shock absorber comprising:

a housing containing a damping fluid;

a guide member disposed at one end of said housing to close off said housing, said guide member having a coaxially disposed opening;

a sleeve disposed within said housing adjacent said guide member and having a coaxially disposed opening;

a piston rod disposed within said housing and having a portion extending outwardly of said housing through said opening in said sleeve;

a damping piston secured fixedly to said piston rod within said housing;

a lockout piston secured fixedly to said piston rod within said housing intermediate said damping piston and said guide member, said lockout piston including a plurality of fluid passageways therethrough extending generally parallel to a longitudinal axis extending through said housing;

a flexible check valve comprising a disc having an opening through which said piston rod extends and being secured adjacent said lockout piston for controlling the flow of said damping fluid through said lockout piston, said valve having a diameter sufficiently large to cover said fluid passageways in said lockout piston and overlaying said fluid passageways as said piston rod is moved toward a position of full extension relative to said housing;

a disc-like support lement fixedly secured to said piston rod adjacent said valve, said support disc-like support element having an outer peripheral portion adapted to overlay said valve;

said valve being operable to flex as said piston rod is initially moved from a position of full extension toward a position of compression, thereby allowing fluid flow through said fluid passageways of said lockout piston, thereby equalizing the pressure on both sides of said lockout piston to minimize the reactive force on the piston rod; and

said outer peripheral portion of said disc-like support element being operable to limit flexing movement of said disc as said piston rod is initially moved from said position of full extension toward said position of compression.

13. The shock absorber of claim 12, wherein said valve further comprises a circumferential slot formed coaxially about said opening therein to enhance the flexibility thereof.

14. The shock absorber of claim 12 or claim 13, wherein said valve comprises a thickness of about 0.004 - 0.020 inch.

15. The shock absorber of claim 14, wherein said disc comprises a thickness of about 0.013 inch.

16. A shock absorber substantially as d scribed h rein with reference to the accompanying drawings.

Applicati n N : GB 9925332.0 Examiner: Kevin Hewitt
Claims searched: 1-16 Date f search: 26 January 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): F2S (SBF, SBG)

Int Cl (Ed.7): F16F (9/24, 9/34, 9/348, 9/512)

Other: Online WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2311354 A	(Munroe Auto Equipment Co.) See Fig.3, flexible disc 102 and passages 104.	1,5,11
X	GB 2266133 A	(Atsugi Unisia Corp.) See Fig.1, valve assembly 4a,5a,6a, etc.	1,2,4-7, 10-13
X	GB 2124328 A	(Boge GmbH) See Fig.1, intake valve 9,7,13, etc.	1,4,5,10, 11
X	US 5823306 A	(Tenneco Automotive Inc.) See Fig.2, flexible disc 62 on intake valve.	1,2,5-7, 11,12

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.